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		Official page numbers:
SALMONELLA ENTERITIDIS PHAGE TYPE 4 IN ONTARIO F-1	177	For reference purposes, citing should refer to the page numbers of the printed copy and not to those of the FAX copy (F-#).
UPDATE: ***STAPHYLOCOCCUS AUREUS*** WITH REDUCED SUSCEPTIBILITY TO VANCOMYCIN – UNITED STATES, 1997 . . . . . F-4	183	

Preliminary Report

SALMONELLA ENTERITIDIS PHAGE TYPE 4 IN ONTARIO

Introduction

Salmonella enteritidis (SE) is one of the most common *Salmonella* serotypes causing human morbidity and mortality[1]. The increasing prevalence of SE has been noted in various countries worldwide[2,3], including a 13-fold increase in human isolates in the United Kingdom between 1981 and 1987[1], and an 8-fold increase (0.5 to 3.9 per 100,000) in the United States between 1976 and 1994; in the United States, SE represented 26% of all *Salmonella* serotypes reported during 1994[4].

In Canada, the number of SE infections recorded by the Bureau of Microbiology, Laboratory Centre for Disease Control (LCDC), has risen since the early 1980s, from 307 in 1983 to 1,255 in 1994. This trend is reflected in both the increasing proportion of infections due to this serotype (17% in 1994, compared to 4% in 1983), and its ranking among serotypes (ranked first or second since 1990, compared with fifth in 1983). In 1991, SE represented 12.5% of human *Salmonella* isolates[5]. In 1994, rates of isolation of this serotype increased to 17%, second only to *S. typhimurium* at 19%[6]. In Ontario, *S. enteritidis* represented 17% (522/3,065) of human isolates in 1996, and *S. typhimurium* 31% (952/3,065)[7].

The increase in human SE infections in Canada is coincident with significant increases in the reporting of two phage types (pt): pt 4 and pt 8. Only two isolates of SE pt 4 were recorded by the National Laboratory for Enteric Pathogens (NLEP) in 1987, compared with an average of over 100 recorded annually between 1992 and 1994. During 1994, 27% (90/331) of human SE isolates received by the NLEP for phage typing were pt 4. That same year, in a limited survey of SE strains in Ontario, 30% (17/57) were pt 4 (A. Borczyk, Laboratory Services Branch, Etobicoke: personal communication, 1997). Other countries have reported even more dramatic increases[1]. For example, in England, between 1990 and 1994, 50% of all *Salmonella* serotypes were SE pt 4[8]; in August 1996, this same serotype accounted for 52% (2,244/4,325)[9].

SE pt 4 is a particular public-health concern because of its association with intact eggs as a major vehicle of *Salmonella* transmission to humans[1,10]. Strains of SE pt 4 are noted for their increased virulence and invasiveness in young broiler chicks, and for their greater resistance to heat exposure, including various methods used to cook eggs[10-12]. Transmission in poultry can be vertical and horizontal. Infected layer hens may be asymptomatic and still lay eggs containing SE pt 4. Multiplication of the organism can occur in eggs at temperatures > 8° C[10].

Until 1994, all human cases of SE pt 4 were implicated with travel, and isolates from environmental samples of poultry flocks were rare in Canada[13]. More recently, three outbreaks of SE pt 4 infection were recorded in 1994: two in Quebec and one in Alberta[6]. In 1995, one additional outbreak of SE pt 4 was reported in Quebec[14]. In 1996, two more outbreaks were reported: one in Ontario and one in Quebec (Dr. Styliadis, Disease Control Service, North York: personal communication, 1997).

Because of these more recent outbreaks and the generally increasing incidence of SE, LCDC – with the cooperation of provincial and local health departments – is currently conducting an enhanced 12-month surveillance investigation of SE infection in the Canadian population. The Ontario data for SE pt 4 collected between 1 May and 31 December 1996 are presented here.

Ontario Investigative Study

Between 1 May and 31 December 1996, the Ontario Central Public Health Laboratory forwarded all SE isolates to the NLEP for phage typing. Identified cases of SE pt 4 were followed up by the Ontario Public Health Branch and local public-health units. Health inspectors investigated cases using a two-page interview questionnaire, requesting information on travel history, egg and other risk-food consumption, and the types of eggs (raw, undercooked, or well-done) consumed.

Cases were classified as domestic or travel-related; cases classified as travel-related reported travelling outside of Canada during the 3 days prior to onset of symptoms. Chi-square analysis was used to determine associations between travel and the consumption of risk foods.

Results

During the first 8 months of the study, from 1 May to 31 December 1996, 68 cases of SE pt 4 were identified among residents of Ontario. This represented 17% (68/399) of all identified SE isolates for the same period. Investigation questionnaires were completed for 65% (44/68) of the cases.

The 44 investigated cases were residents of 16 different health-unit areas; 61% (27/44) reported travelling outside of Canada during the 3 days prior to illness – 11 to countries in Central or South America, seven to Europe, six to South East Asia, two to the United States, and one to Africa. The 17 domestic cases were from nine different health-unit areas. Three had only limited travel within Canada prior to their illness. Nine of the 17 cases were part of the SE pt 4 outbreak in northern Ontario where eggs from a domestic flock were implicated. Age and sex distributions for travel-related and domestic cases were similar. Forty-one percent of all cases (18/44) were male. Age distributions are shown in Figure 1.

Egg-consumption behaviours were similar among those who travelled out of country and those who remained in Canada (Table 1).

Figure 1
Age distribution for domestic and travel-related cases of *Salmonella enteritidis* pt 4 in Ontario

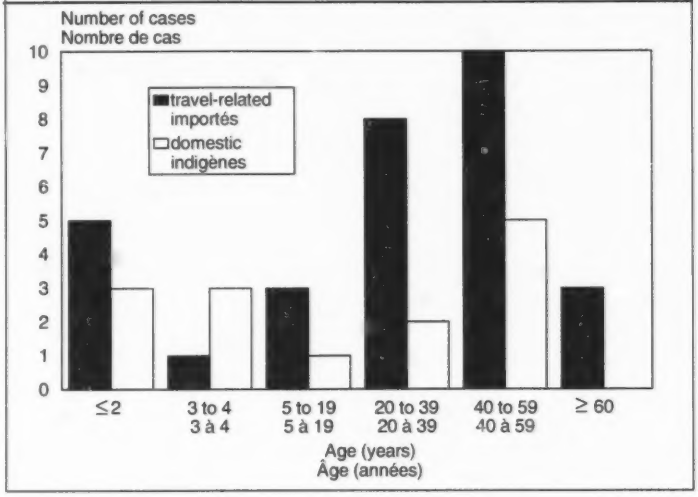


Table 1
Egg consumption by domestic and travel-related cases of *Salmonella enteritidis* pt 4 in Ontario

Eggs consumed 3 days prior to illness	Domestic	Travel-related	TOTAL
Yes	10 (59%)	15 (56%)	25 (57%)
No	1 (6%)	8 (30%)	9 (21%)
Unknown	6 (35%)	4 (15%)	10 (23%)
Total	17	27	44

When asked whether they had eaten raw or "runny" (undercooked) eggs during the 3 days prior to illness, 59% (10/17) of domestic cases said yes, compared to 26% (7/27) of cases with a travel history. The association is statistically significant ($\chi^2 = 4.76$, $p = 0.029$)

Other risk foods consumed by cases during the 3 days prior to illness based on recall are shown in Table 2. The association between history of travel and the consumption of other foods, except for meats purchased frozen, was not significant.

Figure 2 shows the months in which *Salmonella* isolates from domestic and travel-related cases were received by the provincial laboratory; the 17 domestic cases occurred during the warmer months of May to August only.

Table 2
Other risk foods consumed 3 days prior to illness by domestic and travel-related cases of *Salmonella enteritidis* pt 4 in Ontario

Other food consumed	Domestic (n=17)	Travel-related (n=27)	Total
Well-cooked egg	5 (29%)	11 (41%)	16 (36%)
Meringue	1 (6%)	1 (4%)	2 (5%)
Home-made mayonnaise	0	1 (4%)	1 (2%)
Egg sandwich	2 (12%)	3 (11%)	5 (11%)
Other egg dish	3 (18%)	3 (11%)	6 (14%)
Ready cooked chicken	4 (24%)	11 (41%)	15 (34%)
Chicken purchased frozen	4 (24%)	2 (7%)	6 (14%)
Chicken purchased fresh	5 (29%)	6 (22%)	11 (25%)
Sliced meat	3 (18%)	1 (4%)	4 (9%)
Other meat purchased frozen*	4 (24%)	0	4 (9%)
Other meat purchased fresh	7 (41%)	5 (19%)	12 (27%)
Pre-packed raw vegetable	0	2 (7%)	2 (5%)
Raw vegetable or salad	6 (35%)	6 (22%)	12 (27%)

* Chi-square $p < 0.05$

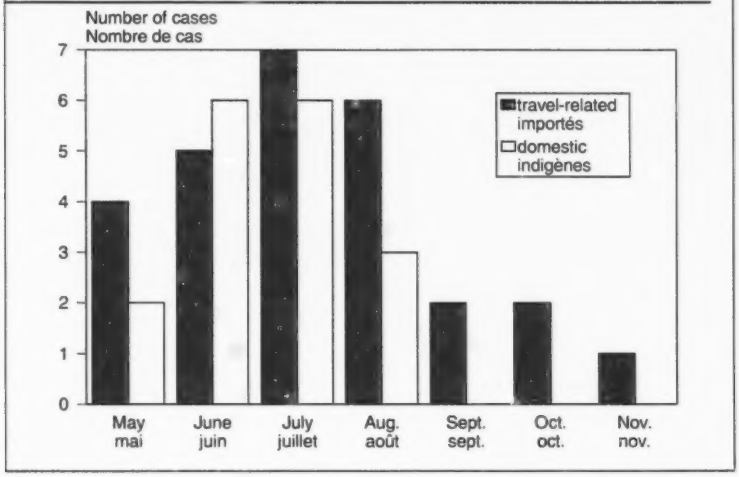
Discussion

The results of this study provide evidence of domestically acquired SE pt 4 infection among Ontario residents. Eight of 17 domestic cases were not associated with the one identified outbreak in northern Ontario previously linked to domestic eggs. This suggests the potential for multiple reservoirs of SE pt 4 in Ontario, although more than one outbreak with a common source may have occurred.

The consumption of eggs and "runny" eggs among domestic cases suggests eggs sold locally as a possible source of infection for residents of Ontario. Undercooked eggs were more likely to have been consumed by domestic cases than by travel-related ones. The true risk, however, of acquiring SE pt 4 from domestic eggs outside of an isolated outbreak cannot be determined without the more definitive evidence of a case-control study of endemic SE pt 4 infection in Canada.

Data continue to be collected on the occurrence of SE across Canada. As information is accumulated, the establishment of

Figure 2
Monthly distribution of isolates received by the provincial laboratory from domestic and travel-related cases of *Salmonella enteritidis* pt 4 in Ontario



SE pt 4 as a domestic concern can be further defined. The results of a 12-month national study will be presented in a final report.

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Source: *S Isaacs, MSc, Field Epidemiology Training Program, P Sockett, PhD, J Wilson, DVM, DVSc, PhD, Bureau of Infectious Diseases, LCDC, Ottawa; S Styliadis, DVM, Disease Control Service, Public Health Branch, Ontario Ministry of Health, North York; A Borczyk, MSc, Laboratory Services Branch, Ontario Ministry of Health, Etobicoke, ON (also reported in PHERO, Vol 8, No 11, 1997).*

Editorial Comment

SE emerged internationally in the 1980s, and its prevalence has subsequently increased rapidly. In 1996, SE accounted for 16.4% (1,576/7,034) of the human *Salmonella* infections reported in Canada and was the second most common serotype isolated after *S. typhimurium*. Of the 984 specimens that were phage typed, the most common phage types identified were pt 4 and pt 8, together comprising approximately 66% of the total number of phage-typed SE isolates. In England and Wales, SE was the most common serotype of *Salmonella* isolated in 1996, accounting for 63% of all *Salmonella* reported in these jurisdictions. SE pt 4 represented 72% of all SE isolations and 45% of all reported *Salmonella* infections in this year[1]. In the United States, SE has also become the most common serotype of *Salmonella* isolated, accounting for 25% of all *Salmonella* reported in this country[2].

SE infections, particularly SE pt 8 in North America and SE pt 4 in Europe, have been associated with consumption of foods containing raw or lightly cooked eggs. One of the largest reported outbreaks occurred in the United States where an estimated 250,000 illnesses of SE pt 8 were caused by a nationally distributed ice cream; the pasteurized ice-cream premix was contaminated during transportation in tanker trucks which had been previously used to haul liquid raw eggs[3]. Outbreaks are often the impetus for public-health officials to investigate foodborne illness, but the greatest burden of foodborne infection occurs among sporadic cases. In order to develop and implement effective public-health strategies to prevent foodborne illness, the epidemiology of sporadic cases must be understood. Phage typing and other new molecular subtyping methods improve the sensitivity and timeliness of a surveillance system especially when the serotype is common. Using these laboratory tools, foodborne outbreaks may be detected that would otherwise have gone unrecognized because of the background "noise" and/or dispersion of cases. The truly sporadic cases are also better identified. For example, a laboratory-based surveillance system using pulsed-field gel electrophoresis assisted the Minnesota Department of Health to identify an endemic strain of SE associated with consumption of Midwestern eggs and to identify an emerging problem of travellers' diarrhea caused by SE pt 4[4].

This report from Ontario provides evidence that infection with SE pt 4 is acquired both domestically and during foreign travel. Of interest is the preliminary evidence that domestically acquired SE pt 4 infections are restricted to the warmer months. This may be related to the higher frequencies of raw egg consumption occurring during the warmer months. The Menu Census Survey conducted in the United States documented that 40% of raw egg consumption occurred during the months of July and September[5]. The higher risk of acquiring infection during this time period may also be a function of an increased probability of contaminated eggs on market shelves.

Twenty-five percent of the cases with SE pt 4 were distributed among the youngest and oldest age groups (≤ 2 years of age and ≥ 60 years of age). Although these are known to be the populations most at risk for salmonellosis, persons in these age groups may also be more likely to see physicians for symptomology and/or have laboratory tests.

Strategies to prevent SE infection caused by egg consumption requires a comprehensive "farm-to-table" risk assessment of eggs and egg products. This includes an analysis of the egg production, processing, distribution, preparation and consumption, and the resulting public-health effects[5]. The enhanced surveillance of SE infection in Canada will greatly assist with a risk assessment of this global emerging problem.

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International Notes

UPDATE: *STAPHYLOCOCCUS AUREUS* WITH REDUCED SUSCEPTIBILITY TO VANCOMYCIN – UNITED STATES, 1997

Staphylococcus aureus is one of the most common causes of both hospital- and community-acquired infection worldwide. Since the emergence of methicillin-resistant *S. aureus* (MRSA) in the 1980s in the United States, vancomycin has been the antimicrobial agent of choice for serious MRSA infections. *S. aureus* with reduced susceptibility to vancomycin (minimum inhibitory concentration [MIC]= 8 µg/mL) was first reported to have caused infection in a patient in Japan in May 1996. In August 1997, the first *S. aureus* isolate intermediately resistant to vancomycin (VISA; MIC = 8 µg/mL) in the United States was reported in Michigan. This report updates the ongoing investigation in Michigan and describes preliminary findings of the ongoing investigation of a second case of VISA infection in a patient in New Jersey.

Case 1: In July 1997, VISA-associated peritonitis was diagnosed in a Michigan resident who was being treated with long-term ambulatory peritoneal dialysis. During January and June, the patient had been treated with multiple courses of both intraperitoneal and intravenous vancomycin for repeated episodes of vancomycin-susceptible, MRSA-associated peritonitis. Although intermediately resistant to vancomycin, the VISA isolate was susceptible to chloramphenicol, rifampin, trimethoprim-sulfamethoxazole, and tetracycline. The patient continues to receive antimicrobial therapy at home. As a part of the investigation, cultures were obtained from the hands and nares of the index patient's household contacts, hospital roommates, and health-care providers. Although *S. aureus* was isolated from 13 (25.4%) of 51 hand cultures and eight (15.6%) of 51 nares cultures, none of these cultures were positive for VISA.

Case 2: In August 1997, a VISA-associated bloodstream infection was diagnosed in a New Jersey resident with long-term MRSA colonization and repeated MRSA infections since February. The patient was not receiving chronic dialysis. In addition, since February, the patient has had vancomycin-resistant enterococcal (VRE) colonization. During March and August, the patient had been treated with multiple courses of vancomycin for repeated MRSA bloodstream infections. In August, a blood culture from the patient grew an MRSA strain with intermediate resistance to vancomycin (MIC = 8 µg/mL); all previous MRSA strains had been vancomycin susceptible. This VISA isolate was sent to the United States Centers for Disease Control and Prevention, where the intermediate resistance was confirmed; the isolate was susceptible to gentamicin, trimethoprim-sulfamethoxazole, tetracycline, and imipenem. The patient continues to receive antimicrobial therapy at home.

MMWR Editorial Note: The emergence of VISA in the United States suggests that *S. aureus* strains with full resistance to vancomycin may eventually emerge. These episodes emphasize the need to enhance laboratory capacity at the hospital and state levels to recognize these strains, the importance of prudent use of antimicrobials, and the requirement for full implementation of recommended infection-control measures to prevent transmission of these strains. To prevent spread of these organisms within and between facilities, health-care providers and facilities are advised

to 1) use a quantitative method (broth dilution, agar dilution, or agar gradient diffusion) to identify these strains; 2) ensure appropriate use of vancomycin, including the review of antibiograms for alternative antibiotics[1]; 3) educate health-care personnel about the epidemiologic implications of emergence of such strains and the appropriate infection-control precautions necessary to prevent their spread; 4) strictly adhere to and monitor compliance with contact-isolation precautions and other recommended infection-control practices; and 5) conduct surveillance to monitor for the emergence of resistant strains. Detailed recommendations to prevent, detect, and control *S. aureus* with reduced susceptibility to vancomycin have been published[2].

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Scientific Advisors	Dr. John Spika	(613) 957-4243
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Editor-in-Chief	Eleanor Paulson	(613) 957-1788
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